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EDITORIAL

FOOT AND MOUTH DISEASE

WE publish in this issue of the VETERINARY JOURNAL an article on foot-and-mouth disease by Professor Flückiger, of Berne, Switzerland. In it he deals with the control of the disease and discusses the method being used in Switzerland, which includes vaccination together with slaughter of animals on the premises of the initial outbreak and the adoption of strict veterinary police measures. Vaccines for the immunisation of livestock against foot-and-mouth disease have been the subject of study for many years in different countries: the most recently introduced products, in which the treated virus is adsorbed to aluminium hydroxide, are now the vaccines chosen by a number of countries for use on a large scale. There are, of course, other vaccines which could be used—for example, that prepared from blood of infected cattle, to which the dye, crystal violet, is added. However, the large-scale operations discussed in the article are concerned with the adsorbed, attenuated virus. It is essential in any scheme of vaccination against any infectious condition that the vaccine used is such that there is no risk of spreading the infection by its use. The vaccine must be incapable of setting up the infection following injection. With a highly infectious virus like foot-and-mouth disease virus it is not difficult to imagine the damage that could be done with a vaccine containing virus still in an infective condition. Further, the virus in the vaccine must be still capable of stimulating an antigenic response in the injected animal of an order sufficient to protect against natural infection at a later date. A careful balance, therefore, has to be obtained between the infective and the antigenic qualities of the vaccine. Again, in dealing with foot-and-mouth disease, the plurity of the virus further complicates vaccination. This is dealt with by using a bivalent vaccine composed of virus of the two most commonly found types. Doubtless, in the event of an outbreak being due to the third and less commonly found type, appropriate vaccine would be available.

Foot-and-mouth disease is a serious menace to livestock production in many parts of the world, and there is no doubt that a method of control as outlined in the article will be found of much value in dealing with the spread of the disease in countries where other methods are of less value. As the author points out,

it is with great difficulty that the disease can be prevented from spreading over frontiers to adjacent countries; there is much to be said for the practice of vaccination together with the other control measures outlined in the article under such conditions. In countries such as Great Britain, however, much thought would have to be given to the subject before vaccination was introduced in the control of foot-and-mouth disease. Foot-and-mouth disease is not endemic in the country; it is introduced from time to time from different sources and, save under exceptional conditions, is rapidly controlled by the slaughtering of infected and in-contact animals, together with the restriction of movement throughout an extensive area. Sometimes an extension of the disease takes place and several farms may be involved, and very occasionally an outbreak may assume somewhat alarming spread throughout areas in the country. Generally speaking, however, the control measures adopted in this country have proved highly successful since they were introduced. The early recognition of the initially infected animals is the key to successful control, no matter which method is adopted. Farmers in this country are very alive to the necessity of reporting the suspicious case to the proper authority.

There must always be a risk attached to the use of a vaccine consisting of an attenuated virus in that the virus may become exalted in virulence and so cause actual infection. Again, there is a further risk that vaccination may tend to mask the symptoms in an already infected animal and lead to a false sense of security. Time is important in controlling foot-and-mouth disease, and it appears to us that nothing would be gained in this country by adopting vaccination as a control policy compared with the measures now in force. In fact, from all the evidence available, it would be decidedly against the present outlook to forego any of the measures in practice by the introduction of a vaccination policy.

What applies to this country does not, of course, hold good in other parts of the world. We are fortunately placed in that wholesale spread of the infection does not take place from neighbouring countries. We are somewhat isolated compared with many other countries and have not the constant fear of a natural spreading of the disease from our neighbours. The protecting of cattle against foot-and-mouth disease in a deep area at and near frontiers is to be commended for, doubtless, spread with consequent loss can so be minimised. Where, however, such an extension does not and cannot occur, as with this country, vaccination with its attending difficulties, including economic considerations, does not apply: the present method of control has proved its worth and, unless circumstances alter very considerably, we should forget about vaccination and continue with the policy now in operation.

GENERAL ARTICLES

COMBATING FOOT-AND-MOUTH DISEASE BY MODERN SCIENTIFIC METHODS

By PROF. Dr. G. FLÜCKIGER
Chief of the Federal Veterinary Office, Berne

I. Appearance and Source of Infection

STATISTICS show that foot-and-mouth disease may spread periodically in a violent form, within a short time, over large areas. In former times its course was marked by rapid spread in Europe where, coming from East to West, it used to overrun the whole Continent in 2-4 years. After its extinction, regular periods followed when the Continent was freed from this plague. Since the introduction of measures by veterinary police to fight this disease, it spreads more slowly and with less regularity in the courses of an epizootic.

In order to understand the periodical and violent outbreaks of foot-and-mouth disease, the sources of the infection have to be considered. The disease is caused by a virus which can be filtered, as Löffler and Frosch proved at the end of last century. In order to produce a new infection, the virus must be able to remain viable somewhere in a virulent condition. In former years the situation was not very clear, and it was supposed that the virus could live for a long time outside the animal body, as happens with numerous bacteria. The most recent investigations have clearly shown, however, that this is only true of a small number of cases. If the virus is attached to animal tissues, scabs of vesicles, etc., it can, according to the investigations of Bedson, Maitland, Burbury and Waldmann, keep alive for months, while it will perish within a short time away from such tissues. But its persistence in animal tissues would not suffice to explain the periodical cycles of epizootics because there is only a limited risk of susceptible animals getting into contact with such a persistent virus. On the other hand, researches have shown that the animal which has recovered from this disease can harbour the virus as a parasite, which retains its virulence and which can leave its host at any moment. These observations have been known for several decades. Such hosts are called germ carriers, infection carriers, germ secretors, permanent secretors, etc. Although germ carriers have, after their survival in an epizootic of foot-and-mouth disease, been observed and described by practitioners long ago, differing opinions were still maintained until Waldmann and his school succeeded in 1930 in proving the existence of such germ carriers, by experiment. The results of these investigations were published by Waldmann, Trautwein and Pyl in their paper, "The Persistence of the Foot-and-Mouth Disease Virus in the Bodies of Immune Animals and Its Secretion," which appeared in the "Zentralblatt für Bakteriologie," Vol. 121, in 1931.

At the present day the existence of germ carriers will scarcely be disputed by any expert. In this respect I may refer to the discussions that took place in the International Epizootic Institute in Paris, at the meetings held between 1937 and

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1939, when not a single delegate contested this point. If experimental investigations, made before or even since those described by Waldmann, led to other results, the reason must be found in the difficulty of demonstrating the presence of the virus. Perhaps new methods of concentration will facilitate a simplification of working methods in the future.

Modern science has, moreover, proved the existence of germ carriers in many, if not in the majority, of infectious diseases, and especially in virus-diseases, in which a number of the animals have remained clinically more or less latent. I may quote cattle-plague, swine-fever, infectious anæmia of horses and horse-influenza. Moreover, I refer the reader to the respective publications by Ch. Nicolle, Lebailly, Stillman, Kolle and others.

Although the occurrence of germ carriers in foot-and-mouth disease is recognised, opinions still differ on the question of how long the virus can be excreted after the animal has recovered, and on the incidence of virus carriers, as both problems are still awaiting solution. There are already statistics on this subject. I may mention the "Observations on the Appearance of Post-infections with Foot-and-Mouth Disease," communicated by the Swiss Federal Veterinary Office in the "Schweizer Archiv für Tierheilkunde," 1923, p. 401. According to this communication the animals that have recovered excrete the virus as long as 30 months after their first infection. Waldmann showed that 2.6 per cent. of the animals which were used for the preparation of hyperimmune serum in the Government Research Institute on Riems Island, near Greifswald (Germany), and which had been thoroughly infected with foot-and-mouth disease, remained permanent excretors.

If virus carriers come into contact with susceptible animals, the latter can be infected. This explains, beyond doubt, a great number of the outbreaks of the epizootic and also part of the spread. Virus-carriers have spread the disease into remote regions. The importation of such cattle for purposes of breeding or general utility to regions that are free of this disease seriously endangers the health of the livestock.

How can the periodical occurrence of foot-and-mouth disease in many districts, and the great differences among the forms of the disease be accounted for?

In the first place, one must point out that the immunity created by this disease does not last long. Infected animals that have survived can be reinfected by the same type of virus a year or two later. Furthermore, various types of the virus have been found so far, a fact to which I shall refer later on. If the type changes within a district, the immunised animals can get the disease again in a short time and in the same degree of intensity as on the first occasion.

After the clearing-up of widely spread epizootics, there will always remain a considerable number of virus-carriers. Now, if such animals come into contact with newborn or with other healthy animals that were imported from other regions, new centres of contagion are formed— as has happened for centuries past— and these centres can spread the disease widely.

Until quite recently it was often maintained that in an outbreak of foot-and-mouth disease the virus should be given an opportunity to wear itself out and to

weaken itself by rapid passage in a great number of animals. This opinion proved to be a fallacy. When no defensive measures are taken, the disease quickly spreads—at least in regions that were formerly free of the disease—from one herd to another and from one species of cloven-footed animal to another species. Because of its unrestricted spread large quantities of infectious material are amassed and distributed by the excretions of the infected animals. The infectious capacity of the virus can increase thereby. The defensive or protective powers of numerous infected animals finally do not suffice to put up a successful resistance against the virus. The serious results are deaths, emergency slaughterings, great losses of milk and meat, rearing losses, reduced working capacity, etc. On the other hand, it has been shown that an energetic application of appropriate protective and combative measures can greatly attenuate the development of the epizootic and considerably reduce the losses. For this reason it is desirable to make the greatest efforts in combatting this disease in every single instance.

The efficiency of protective measures is clearly shown by statistics in that the spread of the disease is not only more or less impeded, but is also retarded by measures of veterinary police, while its occurrences appear to be less regular.

The brilliant success of the " stamping-out " method practised in England, the United States and Switzerland goes to prove that the germ-carriers are responsible for the recurrence of this disease and that its regular or continual appearance is due to insufficient defensive measures. These countries succeeded in keeping their territory practically free from foot-and-mouth disease during long periods, even when it spread widely in other regions. This method is successful as no recovered animals are kept in those countries; when the disease has entered a country by intermediary germ-carriers, its contagious effect is fought in the most energetic and thorough manner by a total slaughter of the infected animals.

Unfortunately, the system of slaughtering has been applied only in a few States, as it has met with great difficulties in other countries for various reasons. In countries whose frontiers open on to large plains and have a heavy traffic of cattle, for instance, the slaughter of the infected animals was impracticable because they were very numerous and most of them had developed the disease within a short time: thus the ensuing economic loss would have been too great. The radical slaughter of all diseased animals in districts where the cattle traffic cannot be thoroughly controlled and an early report of the existence of the disease is not ensured would, therefore, be unsuccessful because the virus spreads rapidly from primary centres. For such reasons—as the past proves—one cannot hope for an international " stamping-out " of the disease by the system of total slaughter only. The best results by the " stamping-out " method have been achieved in countries which are in an insular position—as, for instance, in England—and in those whose frontier-line follows rivers or mountain ranges, such as Switzerland.

From these considerations it follows that the great liability to infection makes it extremely difficult to fight this disease successfully by measures of the veterinary police, whose ordinances alone cannot be expected to achieve a lasting international effect. Circumstances have led a number of countries to introduce and to improve the process of immunisation. There scarcely exists another disease on which so

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many articles have been published than on foot-and-mouth disease. The aim has always been to find a vaccine which—after being deprived of its infectiveness—still retains a sufficiently active, immunising effect upon the susceptible animal. Every method which was successfully applied to the prophylaxis and therapy of other infectious diseases has been tried against foot-and-mouth disease. Simultaneous methods, guinea-pig-passages, culture-passages as well as the addition of chemical agents, dyes, etc., have been used to attenuate the virus until it was sufficiently weakened or diluted in order to be fit for use as a vaccine. These methods were unsuccessful.

The same is true of all attempts to prevent by chemical agents the spreading of the virus in the body of the animal. Chemicals, such as the sulfonamides and penicillin, specific against bacteria, are not effective so far against foot-and-mouth disease, nor against any other pathogenic species of virus affecting human beings or animals.

II. The Elaboration of an Active Method of Immunisation

The discovery of the plurality of the virus of foot-and-mouth disease, made by Vallée and his collaborators, was a decisive forward step in the investigation of immunity. They observed two types of immunisation whose difference consisted in the fact that when animals had gone through an infection of a certain type they afterwards proved to be immune against this special type of foot-and-mouth disease virus but not against other types. Vallée named his two types O and A. His findings were confirmed later by Waldmann, who discovered a third type and named them A (which is identical with Vallée's type O), B (identical with Vallée's A), and C. The plurality is the key to the understanding of the epizootic nature and spread of the infection and is a decisive factor in immuno-therapeutics and the preparation of vaccines against foot-and-mouth disease.

When, in the 1920s, Vallés and his collaborators began to use formalin for the attenuation of the infectious material, new possibilities for protective vaccination seemed to open up. There was a certain amount of success, but attenuation sufficient to ensure the loss of infectiveness could not be achieved, and thus safety of such a vaccine in practical application often meant loss in potency of immunisation.

In scientific research work adsorption has been widely used in experiments in the preparation of vaccines against various maladies. In general, Willstätter's aluminium-hydroxyde was employed as an adsorbent (poliomyelitis, equine encephalomyelitis, fowl-pest).

S. Schmidt and his collaborators in Denmark discovered that the virus of foot-and-mouth disease, when adsorption by aluminium-hydroxide, can—just as Vallée's formalin vaccine—immunise the guinea-pig without any evidence of symptoms of the infection.

Basing their work on the experiments of Vallée and Schmidt, Waldmann and his collaborators developed, on the island of Riems, near Greifswald, a vaccine, the virus of which was, after appropriate adsorption, exposed to treatment with formalin and to heat until it lost its infectiveness, while its immunising capacity

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was fully retained. The positive effect of this new vaccine has now been proved by numerous applications, generally confirmed, to last for the period of eight months, giving cattle protection for this space of time.

At the Conference of the International Epizootic Institute in May, 1939, the successful applications of the "Adsorbat-Vaccine" of Riems in Germany and Switzerland were communicated and given expression by a unanimous resolution, declaring "that the conditions for the prevention of foot-and-mouth disease have been fundamentally changed by the application of active immunisation to this disease. One may now consider the protection of a country against this disease and even hope for its extinction after it has spread over a country." Great progress in combating foot-and-mouth disease was hereby achieved.

The original method of producing this vaccine has been published in detail in the paper, "Die Entwicklung des Riemser Adsorbatimpfstoffes gegen Maul- und Klauenseuche und seine Herstellung," by Prof. Dr. Otto Waldmann, Dozent Dr. Gottfried Pyl, Dr. K. O. Hobohm und Dr. Hubert Möhlmann (Zentralblatt für Bakteriologie, 1941, Vol. 148). One type of this vaccine contains 0.2 per cent. of attenuated virus. The development of immunity begins on the fifth day after vaccination and is usually fully established in a fortnight. The protection will last for eight months or longer. No essential changes in the technique of preparation have been made successfully so far. However, the adsorption power of aluminium-hydroxide has been improved, whereby the concentration of the vaccine has been intensified.

The International Conference on standard methods of production of vaccine against foot-and-mouth disease which took place on September 30-October 3, 1947, in Berne, was attended by delegates of 11 countries. The conclusions described the requirements to be met by the vaccine and concluded that the aluminium-hydroxyde vaccine, prepared according to the principles of Vallée, Schmidt and Waldmann, is, if correctly applied, effective and in every respect innocuous. Furthermore, it has never been observed that immunised animals acquired the disease in consequence of the vaccination nor that they excreted the virus in an infectious form.

The former experiments of Waldmann, tending towards the use of a neuropathic virus of foot-and-mouth disease as an antigen for active immunisation, are of immunological interest. The antigen seems to be successful when applied to pigs, but not yet in its application to cattle. These experiments should be continued.

So far, only the bovine virus has stood the test for the practical preparation of vaccine, i.e., the virus that is obtained by the artificial infection of cattle. Vaccines which are prepared from so-called tissue virus, i.e., from viruses that are obtained from tissue cultures, have proved to be insufficiently effective. The future will show if improvements are possible.

III. The Application of the Vaccine

As we have seen, the aluminium-hydroxyde vaccine (Vallée, Schmidt and Waldmann) was declared by the International Epizootic Institute in Paris, as well as by the International Conference of September/October, 1947, in Berne, to be

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effective and to satisfy the practical demands, while also being innocuous. Since its introduction into practice in 1938, it has factually proved efficient everywhere with millions of animals, insofar as it was prepared and incorporated " lege artis " and corresponded to the types of virus in question. The latter are decisive for the preparation of effective vaccines, that is to say that the types of the virus in the individual epizootics must be known exactly. Without this knowledge, the preparation of vaccine corresponding to the specific types of virus would be impossible, and the success of vaccination in single countries and their frontier neighbourhood could scarcely be expected. If several types have appeared simultaneously in one part of the world, a bivalent or perhaps even trivalent vaccine must be prepared, which is technically quite feasible nowadays. In its resolution, the Berne Conference pointed out that a vaccine, intended for international use, must always be bivalent, i.e., that it must be prepared either with the O and A types of Vallée or the A and B types of Waldmann. The types can be determined by the method of complement deviation or by animal test. If a vaccine is available that meets all requirements, especially those concerning the types used for preparation, great results may be expected, if the other conditions are also fulfilled. The first of these conditions consists in an appropriate vaccination plan. Vaccinations made according to the wishes or demands of the individual owner of the animal or of commercial enterprises can never be successful in times of epizootics, i.e., they cannot help to stamp out the disease. The entire planning and execution of the vaccinations must be in the hands of the responsible authorities. They must always have the power to apply vaccination and to take any measures of veterinary police under the control of the authorities. Thus, vaccination can only achieve its purpose as a compulsory measure. In order to ensure its application without friction, the veterinary surgeons and the owners of the animals must be widely informed by direct instruction and public notices.

An alert and keen working epizootic service should in the future furnish international information, not merely concerning the spread of the disease, but also on the exact type occurring in the infected countries. This would not only put the non-infected countries in a position to institute early measures of the veterinary police, but also to set up a broad protective screen at their frontiers, by vaccinating all of their susceptible cloven-footed animals against the types whose importation is to be feared. Such protective action was, moreover, recommended by a resolution of the International Epizootic Institute in Paris in October, 1946. If, in spite of these defensive measures heavy movement of cattle should lead to outbreaks of the disease behind the protective screen, it can be " stamped-out " by immediate measures, if needs be, by slaughterings, and a further spreading be prevented by extensive general vaccination. In this case also a perfect organisation, under the leadership of experienced specialists, who take quick decisions, is of first importance.

In many countries the fullest utilisation of vaccination in combating foot-and-mouth disease is still in its early beginnings. It presupposes a perfect administration and a capable, well-organised and generally recognised veterinary legislature. Moreover, the financial question must be solved by the government in such a

manner that private, economic interests cannot cause the obstruction of such a programme.

The advantages of vaccination will be evident primarily in those countries where the " stamping-out " method prevails. General vaccination of the exposed animals in the surrounding vicinity of the slaughtered stock will prevent the spread of the disease. The good effect of the slaughtering method has been clearly improved upon by vaccination. Before such vaccination was practised, it was impossible to protect the exposed animals against the surrounding primary centre of infection. The measures taken by the veterinary police often proved quite insufficient in themselves to prevent further infection, so that a great number of animals had to be slaughtered in order to suppress the epizootic. Nowadays the situation is much more favourable. By applying vaccination at the same time as the slaughtering of the primarily infected stock the disease can be stamped out mostly within a short period. Such a system is also financially much cheaper than the " stamping-out " method alone, as the quickly achieved immunisation protects many animals that would otherwise have also to be slaughtered.

In those countries where the isolation of the infected stock is the chief measure of defence, a careful introduction of vaccination into the official ordinances will be necessary, in order that vaccinating will be carried through without friction and that success will be ensured. At all events, the results of the wide, well-planned vaccinations that have been practised since 1938 seem to prove:

1. That exposed regions can be protected against the disease by the formation of rings or barriers, and
2. that epizootic outbreaks can be isolated by systematic vaccination of the exposed stock, i.e., by a general vaccination, combined with measures of the veterinary police, and can in this manner be suppressed.

Here we must repeat once again that the quarantine measures of the veterinary police must be carried out most thoroughly. Furthermore, vaccination also can only be successful if reliable and early reports of outbreaks of the disease are ensured.

The reasons why such outbreaks cannot be efficiently suppressed by vaccination alone are:

1. The virus of foot-and-mouth disease is extremely infectious, and
2. After vaccination at least 12 days are needed for the development of immunity.

As has been shown, vaccination is most effective when combined with the slaughtering of animals suffering from foot-and-mouth disease. Since active immunisation was started, the following system of combating this disease is practised in Switzerland:

1. Immediate slaughtering of the infected animals.
2. Vaccination of the exposed cattle stock, i.e. of those animals which are suspected of having had any contact with the centre of infection (general vaccination).
3. Immediate disinfection of the infected and exposed farms.

4. Quarantine measures against the traffic of persons, animals and animal products.

By this system, all outbreaks of the disease were limited to their primary origin. This method consists—popularly speaking—in encircling the enemy and making him innocuous. Besides this, the danger of importing the disease from foreign countries can be prevented most effectually by setting up barriers along the frontiers, i.e. by periodical prophylactic vaccination of the cattle stock in the zones that are threatened. The entire system would, without doubt, hold good in every other country, while differing local conditions would naturally be taken into account. A description of all the modifications that may have to be considered would go beyond the limits of this paper.

Vaccination has already shown favourable results in international traffic of cattle. The animals in question can now be actively immunised at their place of origin, so that they do not risk being infected during their transport, not even if they have to be transported through countries in which cases of foot-and-mouth disease occur at the time. The International Epizootic Institute in Paris has also been concerned with this question and has, in a resolution of October, 1946, stated that cattle coming from regions that are free of this disease and which have had prophylactic vaccine treatment before can be admitted to international traffic without further notice.

The development of foot-and-mouth disease vaccine is a great boon and constitutes a success such as is rarely achieved in veterinary medicine. It is now possible to immunise safely for months susceptible animals against every type of virus, without any harmful consequences whatever, while transmission of foot-and-mouth disease by such animals is precluded.

In countries with sufficient means of transport and an appropriate organisation of its veterinary service, the application of vaccination offers no difficulties in its present form. But for other countries the vaccine still has two disadvantages. One is the relatively large doses that are necessary for immunisation—30 c.c. are needed for one animal—and the other is its great sensitiveness to temperature. In order to retain its efficiency, the vaccine must be kept at a temperature between +2° and +8° C., which is not always easy, especially in tropical countries. Finally, this vaccine does not retain its efficiency for more than about 8 months. Yet it is to be hoped that science may succeed in achieving further improvements, as the resolutions of the Berne Conference of 1947 expressed.

The respective resolutions are appended.

IV. Summary

1. The chief source of infection with foot-and-mouth disease is found in animals that have survived the disease, a number of which remain germ-carriers for a long period.
2. Germ-carriers can be eliminated by slaughtering, i.e. by the " stamping-out " method.
3. The aluminium-hydroxide preparation produced according to the methods

of Vallée and Schmidt and Waldmann represents an efficient prophylactic vaccine, by which susceptible animals can be safely immunised for months.

4. By an appropriate application of carefully prepared vaccine of this type, it is possible to protect whole countries from this malady or to prevent existing centres of this disease from spreading it.
5. Success can only be achieved if the vaccine is applied according to an official government plan, while all necessary measures of the veterinary police are carried out at the same time.
6. Animals that have been carefully treated by prophylactic vaccination and have not already suffered from foot-and-mouth disease are quite innocuous and do not spread the disease; thus they can be admitted to international traffic. Quarantine measures against such animals are no longer justified by veterinary police, especially if the animals come from absolutely healthy regions.

RESOLUTIONS

concerning the standardisation of methods for the preparation of foot-and-mouth disease vaccine

Following a resolution of the International Office of Epizootics at its meeting in Paris, May, 1947, a conference under the auspices of the Office was held at Berne from September 30 to October 3, 1947, to consider uniform methods of preparation of foot-and-mouth disease vaccine. After considering reports and discussing the problem, the following resolutions were adopted by the delegates:

1. They confirm that at the present time the vaccine prepared with aluminium hydroxide according to the method of Schmidt-Waldmann, if properly employed, is effective and absolutely safe. It is especially noted that it has never been observed that immunised animals have developed the disease following vaccination, nor do they eliminate virus.
2. In order to meet international requirements, the vaccine should have the following qualities:
   (a) It should have been submitted to a test, involving both subcutaneous and intralingual injections, which should confirm the absence of detectable active virus.
   (b) It should be bivalent and contain the strains of type O and A, Vallée (A and B, Waldmann), if the prevailing conditions do not warrant another composition.

   The determination of the type should be established by approved biological methods. It is recommended that the value of the complement fixation test should be studied and if the results reported are sufficiently reliable it should be adopted. In this connection, the institutes at Amsterdam, Brescia and Santiago, Chili, will furnish such aid as may be desired.
   (c) The general dose for large animals should contain a minimum of 0.1 gr. of each virus type, each being ineffective for cattle in a minimal dose of one in one million.

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(d) It should contain neutral or slightly alkaline aluminium hydroxide and have an adsorbing power sufficient to guarantee a margin of security which excludes the possibility of infection by vaccination.

(e) It should contain an extract of virus prepared from infected material by methods which assure its maximum suspension.

(f) It should be bacteriologically sterile.

(g) It should be attenuated by the simultaneous action of a maximum of 0.05 per cent. of pure formaldehyde (CH_2O) and moderate heat.

(h) It should immunise large animals in a single dose of 30 c.c. The uniformity of the dose is of practical importance to importing countries. The immunity is considered to be adequate when the test carried out with the strains from which the vaccine is prepared does not lead to a generalised foot-and-mouth disease infection in a fixed proportion of the test animals (this proportion to be determined experimentally as the adequacy of the test will be governed by the method of infection and the susceptibility of the test animals).

3. The delegates express the wish that those countries producing vaccine which were not represented at the meeting in Berne, November 22, 1946, adhere to the arrangement concluded at that date and that those countries not present at this conference adopt the above resolutions.

4. The delegates are of the opinion that better arrangements should be made between the various countries with regard to the production of vaccine. This would overcome the difficulties existing at present whereby countries which are making vaccine are obliged either to maintain, at their own risk, large reserves of vaccine against the eventuality of a combined international compaign or, on the contrary, for fear of wastage, to hold insufficient reserve stocks.

5. The delegates strongly recommend that further research studies be made on an international basis and that the Directors of institutes preparing vaccine and those engaged in research meet at regular intervals under the auspices of the International Office of Epizootics.

Prepared at Berne, October 3, 1947.

For the delegates from:

Belgium	Dr. Willems
Brazil	Dr. Torres
Chili	Dr. Rodriguez
Denmark	Dr. Schmidt
France	Dr. Thiéry
Great Britain	Dr. Galloway
Italy	Prof. Ubertini
Morocco	Dr. Placidi
Holland	Dr. van Waveren
U.S.A.	Dr. Schoening
Switzerland	Dr. Moosbrugger

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SWAYBACK INVESTIGATIONS: THE INFLUENCE OF INGESTED LEAD AND CERTAIN OTHER ELEMENTS ON THE BLOOD COPPER OF SHEEP

By W. S. FERGUSON

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THE swayback disease of lambs appears to be due to a deficiency of Cu within the animal, but not necessarily by reason of a Cu deficiency in the ration. Faulty absorption or utilisation seems evident.

The occurrence of lead in the soil of the swayback areas has frequently been noted but satisfactory proof that lead is a major factor in the disease is lacking. Shearer and McDougall (1944) state, ". . . it is not thought that lead is the most important factor in the causation of the disease, but rather the prime motivator is the 'conditioned' Cu deficiency and that lead accentuates the pathological changes produced by the Cu deficiency." They also point out the frequent association of fluorspar with lead ores in the affected area in Derbyshire.

No attempts appear to have been made to see if the direct administration of lead to sheep causes any lowering of the blood Cu content or if abnormal lambs are produced when lead is administered to the ewes.

From 1942 to 1944 several experiments were made at Jealott's Hill to investigate this point. These were of an exploratory nature and publication of the results was not intended at this stage. Since, however, pressure of other work

has interrupted the investigation, the results of the most interesting of the experiments are presented in order to save unnecessary duplication of work by other workers on the swayback problem.

Experimental

In the winter 1943-4, the effect of feeding Pb and also Pb plus certain other minerals likely to occur naturally with Pb was investigated.

Twelve suspected in-lamb crossbred ewes, purchased in early December, 1943, were divided into groups of two for the following treatments:—

Ewe No.	*Treatment*
1 and 2	164 mg. Pb daily
3 „ 4	164 „ „ and 489 mg. other salts* daily
5 „ 6	219 „ „ daily
7 „ 8	219 „ „ and 489 mg. other salts* daily
9 „ 10	273 „ „ daily
11 „ 12	273 „ „ and 489 mg. other salts* daily

* The salts consisted of:

0.133 g. sodium fluoride containing 60 mg. F.
0.180 g. barium chloride „ 100 mg. Ba.
0.036 g. silver sulphate „ 25 mg. Ag.
0.140 g. antimony potassium tartrate containing 50 mg. Sb.

The ewes were fed seeds, hay and mangolds, and the daily supplements of Pb, as lead acetate, and salts were given in about ½ lb. crushed oats. After lambing some protein cake was given in addition and the ewes and lambs allowed to run out on poorish pasture.

The Cu content of the hay was 5.6 p.p.m. and it is presumed that the total ration contained 5-7 p.p.m. Cu. The Cu requirement of ewes is not known with any certainty but a ration containing 5 p.p.m. probably approaches the minimum requirement.

Daily dosing with Pb, etc., commenced on December 20, 1943, and continued until April 22, 1944, except in the case of ewe No. 4 which became unwell in early March when it was thought advisable to stop the dosing. This ewe gave birth to dead twins on March 7. Ewes 11 and 12 refused their supplements for four days in late January but these were the only refusals.

Blood samples, for Cu determinations, were taken from the ewes at intervals from December 23, 1943, to May 11, 1944. Samples were also taken from the surviving lambs on April 24.

Results

Lambs born.—Ten ewes produced lambs; the other two proved barren. Seven lots of twins were born but of these, two lots were born dead and in two other lots one twin died soon after birth. All single lambs were quite strong. The surviving lambs progressed rapidly and were extremely active. At no time was there any staggering or signs typical of swayback.

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The lambs born were as follows:—

Lead only

Ewe No.	*Lambing date*	*Description of lambs*
1	20. iii	Strong single
5	12. iii	„ „
6	1. iv	Weak twins, 1 died
9	12. iii	Twins born dead, about full-time
10	8. iii	Weak twins, 1 died

Lead + other salts

Ewe No.	*Lambing date*	*Description of lambs*
3	2. iii	Good, fairly strong twins
4	7. iii	Twins born dead, one undeveloped and had evidently been dead some weeks
8	14. iii	Strong single
11	14. iii	Twins, one rather weak
12	15. iii	Weak twins

The number of lambs is obviously too few to indicate any differences due to level of Pb intake or the effect of the additional salts. Even in the absence of control animals the results do, however, suggest that lead ingested as lead acetate adversely affected the health of twin lambs.

The brains and spinal cords of five of the lambs which were either born dead or died shortly after birth were examined by Dr. J. R. M. Innes who reported that there were no lesions of any pathological significance in any of the brains and none which denoted either swayback or chronic lead poisoning.

TABLE I

Copper in ewes bloods, mg. per 100 *ml.*

Ewe No.	23. xii	21. i	9. ii	1. iii	22. iii	12. iv	11. v	Maximum fall from initial value
Lead only								
1	.100	.096	.096	.100	.052	.116	.112	.048
2	.082	.072	.072	.090	.080	.064	—	.018
5	.095	.100	.086	.072	.064	.068	.108	.031
6	.095	.100	.073	.046	.042	.064	.084	.053
9	.078	.100	.082	.052	.096	—	—	.026
10	.085	.096	.064	.072	.072	.068	.100	.021
Mean	*.089*	*.094*	*.079*	*.072*	*.068*	—	—	*.033*

Ewe No.	23. xii	21. i	9. ii	1. iii	22. iii	12. iv	11. v	Maximum fall from initial value
Lead + other salts								
3	.112	.100	.100	.086	.060	.068	—	.052
4	.108	.096	.090	.052	.012	—	—	.096
7	.112	.108	.055	.025	.020	.020	—	.092
8	.132	.126	.073	.072	.060	.064	.084	.072
11	.108	.108	.060	.056	.064	.068	.100	.052
12	.064	.056	.016	.020	.030	.020	.108	048
Mean	*.106*	*.099*	*.066*	*.052*	*.041*	—	—	*.069*

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This negative finding was not altogether unexpected in view of the satisfactory growth rate and marked activity of the surviving lambs. It should be noted, however, that only one brain (No. 4) came from the "Lead + other salts" group and this was too decomposed to be worth examining.

Copper contents of bloods.—The Cu contents of the bloods of the ewes are given in Table 1. These were determined by the method of Eden and Green (1940).

In both main groups there was a variable lowering of the blood Cu level until late March but the fall was not correlated with the quantity of Pb ingested. The fall was markedly greater in the "Pb + other salts" group. The significance of these changes in blood Cu will be considered in the discussion.

The blood Cu contents of the eleven surviving lambs were determined on April 24, 23-53 days after birth. The figures are given in Table II and they show wide variation. It is evident, however, that many of the lambs had very low blood Cu contents.

TABLE II

Copper in lambs bloods, mg. per 100 ml.

Lamb from Ewe No.	*Days from lambing*	*Blood Cu*
1	35	.038
5	43	.030
6	23	.038
10	47	.046
3 (1)	53	.126
3 (2)	53	.072
8	41	.020
11 (1)	41	.068
11 (2)	41	.072
12 (1)	40	.038
12 (2)	40	.030

Discussion

The blood Cu level in normal sheep apparently varies widely from one district to another (Innes and Shearer, 1940; Eden, 1939), and is presumably controlled by the nutritional adequacy of the foodstuffs ingested. In the present experiment, the average Cu figures obtained on December 23, 1943, were perhaps somewhat low but within the expected range for normal sheep. In the "Lead only" group, Pb feeding resulted, after three months, in a mean fall of Cu of 0.031 mg. per 100 ml, the mean level in late March being 0.068 mg. This level of 0.068 mg. might be considered fairly normal but the regularity of the decrease with time certainly suggests that Pb or some other factor was influencing the Cu content. Eden (1939, 1941) has stressed the variability in blood Cu content from month to month and it is perhaps unwise to consider the behaviour of the individual sheep in the present experiment.

Eden (1941) and McDougall (1947), from studies with normal ewes, both conclude that pregnancy causes no characteristic change in the blood Cu level. The steady fall in the blood Cu figures quoted in Table I is, therefore, not a normal

feature during gestation and suggests that Pb had some action. The different levels of Pb intake had no obvious effect.

In the "Pb + other salts" group all the ewes showed a marked fall in blood Cu, the mean fall being double that shown by the "Lead only" group. There was marked variation between sheep, but in three, in late March, the blood Cu level was seriously low. It seems apparent that one or more of the elements fed affected the blood Cu but it is not possible to say whether the element or elements were supplementing the Pb effect or if the effect was quite independent. Whether or not this observation has any bearing on swayback cannot be answered at present and more detailed chemical analyses of the herbage, and the soils and dusts which are ingested with the herbage in the affected areas, will be required to elucidate the matter. It is interesting to note that Shearer and McDougall (1944) have pointed out the frequent association of fluorspar with Pb ores in the swayback areas of Derbyshire.

The feeding of Pb, etc., was stopped on April 22 and the final blood samples taken from seven ewes on May 11 showed a marked rise in Cu content over the samples taken a month earlier. Two factors may have influenced this rise. Firstly, the cessation of the supplementary feeding of Pb, etc., and secondly, a greater intake of grazed herbage. No analysis was made of the herbage but presumably its Cu content was greater than that of the hay ration. The ewes were allowed to graze immediately after lambing and practically all lambed by the middle of March. The blood samples taken on April 12 indicated a rise in blood Cu in only two ewes, the others remaining constant. It is probable that the quantity of grass grazed at this period was less than in late April and early May when growth was rapid, but while increased ingestion of grass may have contributed to the rise in blood Cu in May, the termination of the feeding of Pb, etc., was probably of more significance.

Summary

A group of six in-lamb ewes was fed varying quantities of Pb, and another group similar quantities of Pb plus a mixture of salts of F, Ba, Ag and Sb. The period of feeding these supplements before lambing time was about 11 weeks. In both groups some lambs were born dead, twins were weak and single lambs were strong. No signs typical of swayback were noted.

The blood Cu level of the ewes receiving Pb alone fell by a mean of 0.033 mg. per 100 ml., and that of the ewes receiving Pb + other salts by 0.069 mg. Some of the surviving lambs had very low blood Cu values.

The results suggest that while Pb alone caused some lowering of the blood Cu of in-lamb ewes, the other elements either supplemented the Pb effect or had an independent effect on blood Cu.

The author wishes to thank Dr. J. R. M. Innes for undertaking the examination of the lambs' brains.

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X-RAY EXAMINATION OF "EPIPHYSEAL UNION" AS AN AID TO THE ESTIMATION OF THE AGE IN DOGS*

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A FEW years ago Dr. Emara Bey, Professor of Forensic Medicine, on Faculty of Medicine and at the Veterinary College, using X-rays, carried out a line of research on the epiphyseal union of bones in young Egyptian cattle for the verification of their ages. The work was done in the X-ray Department of the School of Veterinary Medicine.

A report of this research was published in the *Veterinary Record*, December, 1937.

His research attracted my attention and induced me to carry out similar work with regard to the dog. In this animal, accurate estimation of age by dentition beyond the seventh month is not possible. After the seventh month the dog would have lost all his milk teeth for a complete set of permanent ones. Beyond this estimates based on appearance of the incisors cannot be depended upon, as the wear and tear in these teeth varies according to the kind of food given to the animal. Radiological examination of the epiphyses has enabled me to fix the age up to two years. Dr. Emara Bey supervised my work.

With the existence of many breeds of dogs in Egypt, it was necessary to select one or two types for carrying out the work. The animals had to be of medium size, born in Egypt, have registered age certificate and exhibit normal growth. They had to be at hand for X-ray examination at specified times.

The Alsatian dogs presented by His Majesty the King to the Police College, and the Armant dogs of the Zoo, were found suitable. They are of pure blood, medium size, well nourished, under good observation and control, and they have registered ages. Owing to an outbreak of distemper I had to give up the research on the dogs of the Police College and concentrate on the pure Egyptian Armant dogs at the Zoo. It was through the assistance of the authorities at the Zoo that I was able to carry out this work to completion.

The whole work was recorded on 313 films, excluding the unsuccessful ones.

The aim of the work was to try to solve such problems of estimation of age of the dogs which the veterinary surgeon may encounter in his practice. Also from the veterinary legal point of view this matter is extremely important, for practitioners are frequently called to assist the courts when there is litigation affecting age.

The Scheme of the Work

From the table of comparison one notices that the fore limb gave the data of appearance and union as follows:—

The Scapula

The only epiphyseal union that could be detected in this bone was that of the tuber scapulæ, which showed no sign of union before the fourth month.

* Summary of a thesis for the Degree of M.V.Sc.(Cairo), Fouad I University.

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FIG. I (above).—(1) Proximal and distal end of humerus show no union. (2) Proximal and distal end of radius show no union. (3) Olecranon and distal end of ulna show no union. (Note the characteristic V-shaped area of ulna.)

FIG. II (right).—The first digit (the thumb in man) has three phalanges as the proximal bone follows radiologically the rule of phalanges in its ossification, i.e. the separated end being proximal, unlike the metacarpal bone, i.e. the separated end being distal.

PLATE I.—Article by Kamal Seoudi

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FIG. III (above).—The characteristic pyramidal - shaped segment appears between the two innominate bones at the centre of the ischial arch.

FIG. IV (right). — The pyramidal bone united with ischial arch while the whole two innominate bones still separate.

PLATE II.—Article by Kamal Seoudi

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FIG. V (above).—(1) The bones of the os coxæ show no union. (2) The two bones of innominate show no union. (3) Proximal and distal ends of the femur show no union.

FIG. VI (right).—(1) Distal end of femur shows no union. (2) Proximal end of tibia shows no union. (3) Proximal end of fibula very clear and shows no union.

PLATE III.—Article by Kamal Scoudi

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The union began during the fifth month and was completed during the sixth month in all the cases radiographed.

The Humerus

(*a*) The proximal end.

The proximal end has two centres, one for the upper extremity and the other for the external tuberosity. Both were apparent in the first month, began to unite during the eleventh month and were completely united towards the end of the first year.

(*b*) The distal end.

In each of the cases examined, the epiphysis of the lower end began to unite with the shaft at the seventh month and was completely united at the eighth, except in one case (Helwan), in which union started slightly earlier, i.e., in the middle of the seventh month, and ended in the middle of the eighth month.

The external condyle was seen to be united with the body at the sixth month. The inner condyle united at the eighth month.

The Radius

(*a*) The proximal end.

The upper extremity has only one centre, which appears at about the first month. It began to unite to the shaft at about the eighth month and it was completely united in the ninth month.

(*b*) The distal end.

The distal end of the radius commenced to unite to the shaft after the beginning of the tenth month and was completely fused towards the end of the first year.

The Ulna

The two centres of ossification of the olecranon process and the lower extremity of the ulna appeared at the second month.

The olecranon was shown clearly as a separate bone till the ninth month and was completely united during the tenth month.

The distal end has a very characteristic V-shaped appearance and unites towards the end of the first year. In the previously mentioned case (Helwa), the union of both centres of radius together with that of the distal end of ulna occurred rather early.

The Metacarpals

Although the four metacarpals of the dog are of different lengths, yet there was no difference regarding the appearance and complete union of their epiphyses. Each metacarpal has two centres, one for the shaft and the other for the distal end. The latter started to unite during the seventh month and was completely fused about the eighth month.

The Digits

In the manus of the dog there are five digits. The innermost digit does not

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come in contact with the ground in walking. Each of these digits possesses three phalanges, but no navicular bone is present. The third phalanx is a small hook-like bone with a projection or collar of bone encircling its base, which takes the place of a navicular bone.

The first phalanx in the dog has only two centres of ossification, one for the shaft and the other for the upper extremity, which started to unite about the sixth month and was completely fused about the seventh month.

The second phalanx, though considered by some authors as a short bone, has two centres of ossification, following the rule of a long bone, one for the shaft and the other for the upper extremity. They united one month earlier than the first phalanx (six months).

The Hind Limb

The three bones of the innominate bone, the ilium, ischium and os pubis, are usually separate till the fifth month and union is complete towards the beginning of the sixth month.

The crest of the ischium was found united with the bone at the end of the first year or early in the beginning of the second year. The crest of both ilium and os pubis was not easy to detect in the different radiographs taken.

The Two Innominate Bones of the Pelvis

At the seventh month a characteristic, small, pyramidal bone appeared situated in the centre of the ischial arch. Its apex was directed to the front. This bone was gradually united with the two ischial bones. This union then extended forwards in the median line of the floor of the pelvis with the exception of the extreme anterior end of the symphysis, in which no signs of union were seen till twenty-four months or even later.

The Femur

I could detect the proximal end and the great trochanter as separate bones up to the seventh month. After that age no X-ray manifestations of value in the upper end of the femur could be relied upon, probably due to overlapping of different bones and scattering of the rays. Both the upper extremity and the great trochanter were observed to unite about the ninth month.

The distal end of the femur united with the shaft about the end of the first year.

The Tibia

(*a*) The proximal end.

The proximal end started to show signs of union at about the eleventh month, while complete fusion occurred at the end of the first year or slightly later (thirteenth month).

The external tuberosity of the upper end of the tibia showed union at about the thirteenth month.

(*b*) The distal end.

The union of the distal end of the tibia to the shaft commenced during the tenth month and was completed by the eleventh month.

The Fibula

The epiphyseal union of the upper extremity started to show signs of union at about the eleventh month and was completed at the end of the first year.

To show the distal end of the fibula radiographically it is necessary to take an antero-posterior view, which was rather difficult in the dog.

Os Calcis

The tuber calci of the os calcis started to show union during the middle of the seventh month, and at the beginning of the eighth month complete union took place.

In the exceptional case of "Helwa" appearance and union showed earlier in the hind limb, as it did in the fore limb.

The Metatarsals and Digits

These followed the same process of ossification as the metacarpals and their digits. In most of the dogs there were only four metatarsals and four digits.

Comments on the Work and New Facts Discovered

On comparing my data and figures with those of Sisson one notices that:—

(1) Sisson had worked on the bones of dead dogs. The present work is done radiographically on the bones of living animals. We agreed in a number of dates of epiphyseal union, e.g. the union of the tuber scapulæ, both extremities of the humerus, the upper extremity of the radius and the three bones of the os coxæ, etc.

(2) The slight diference in the figures given by Sisson and me regarding the distal end of the metacarpals and the proximal end of the digits (about one or two months) is not of great importance and could be explained on mode of living, racial, environmental and climatic grounds.

(3) There are certain gross differences in reference to other bones, e.g. the lower end of the radius. Sisson gave the eighteenth month as its date of union, while in my collections it was found completely united at the twelfth month.

Regarding the ulna, Sisson gave the fifteenth month as the date of union of both its upper and lower ends, while with us the upper united at about the tenth month and the lower united at the twelfth (nearly the same age of union as both upper and lower extremities of radius).

(4) As to the union of the crest of ilium and tuber of ischium, Sisson stated that both united at about two years. In our collections the tuber of the ischium was found united at about one year. The crest of the ilium was not seen clearly,

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due to the difficulty of putting the dog in a suitable position for radiographing this particular part of the bone.

(5) Sisson gave the dates of union of both upper and lower extremity of the femur as the eighteenth month. I found that the upper united earlier than the lower, ninth and twelfth months respectively.

(6) A similar difference is recorded with regard to the tibia. Sisson gave eighteen months for the union of its upper extremity and fifteen months for its lower one, while we found that they united somewhat earlier, twelve months for the upper extremity and eleven for the lower.

(7) We could find no mention in the literature about the upper end of the fibula, which was seen radiographically to unite at about the same age as the union of the upper extremity of the tibia was effected (twelve months).

(8) The epiphysis of the os calcis was seen to be united at about the eighth month, much earlier than was recorded by Sisson (fifteen months).

(9) Some books on osteology mention that the scapula of the dog bears no coracoid process, but I believe that it has one on the tuber scapula, though very small.

(10) All books on osteology—with no exceptions—consider that the dog has five metacarpals. My radiological research reveals that he has only four metacarpals. They consider the first bone in the innermost digit (the thumb in man) to be a metacarpal bone, but we found that it follows radiologically the rule of a phalanx in its ossification, i.e. the central end being proximal, unlike the metacarpal bone, i.e. the central end being distal.

(11) Considering the above fact and regarding the number of phalanges of the first digit, we cannot agree with those who consider that the first digit has only two phalanges (second and third) in the belief that the first phalanx of this digit is *probably* united to the lower end of its metacarpal bone. As pointed out above, this digit has three phalanges and thus is not a metacarpal bone.

(12) I could not find any radiographical data to verify the statement that there are centres for the upper extremity of metacarpals and lower ends of digits which consolidated before birth, but this probably needs a special research to prove it.

(13) One also notices from the above-mentioned figures that the ends of bones entering into the formation of the elbow (humero-radial) joint unite generally about the same period (eight to nine months).

(14) The above-mentioned union (elbow joint) occurs earlier than the upper extremity of humerus and the lower extremity of both radius and ulna, which unite at the same period, i.e. the first year.

(15) The ends of bones entering into the formation of the stifle (femero-tibial) joint unite at about the same age, i.e. twelve months.

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I express my thanks and gratitude to both Dr. M. Emara Bey and M. Housny, D.V.H., M.S.R., the head of the Radiological Department in the Veterinary College, who greatly facilitated this work.

SUMMARY OF RESULTS

Name of bone	Region	Collection of dogs examined	Sisson's
Scapula	Tuber scapuli	Union in the sixth month	6-8 months
Humerus	Proximal	Union about one year	1 year
	Distal	Union seventh to eighth month	7-8 months
Radius	Proximal	Union during the ninth month	6-8 months
	Distal	Union about one year	1½ years
Ulna	Olecranon process	Union during the tenth month	15 months
	Distal	Union about one year	15 months
Metacarpals	Distal	Union towards the eighth month	6-8 months
1st phalanx	Proximal	Union towards the seventh month	5-6 months
2nd phalanx	Proximal	Union towards the sixth month	5-6 months
The 3 bones of the innominate	Acetabulum Symphysis pubes	Union during the sixth month	6 months
Pelvis	Proximal	Union after the end of two years	Unmentioned
Femur		Union not so clear, and generally takes place about tenth month	1½ years
	Distal	Union during the end of the first year	1½ years
Tibia	Proximal	Union at one year or thirteenth month	1½ years
	Distal	Union generally takes place towards the end of the eleventh month	14-15 months
Fibula	Proximal	Union during the end of the first year	Unmentioned
Os calcis	Tuber calci	Union towards the beginning of the eighth month	14-15 months

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THE EFFECT OF IODISED PROTEIN ON THE LAYING CAPACITY OF HENS

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THE past 20-30 years has seen many advances in elucidation of the physiological functions of the endocrine or ductless glands. These glands are the sources of production of a number of specific secretions or hormones which are elaborated in the glands, secreted directly into the blood stream and conveyed thence to the organs of the body over which they have a controlling influence. Among these glands, one of major importance is the thyroid gland which exerts a dominating action on the metabolism of the body and therefore influences a number of its physiological processes. Among these functions the secretion of

											PERIOD	TEST FEE
Control	Dec. 1945	Jan.		Feb.		March		April		M	Jun
1 ...	17	34	51	35	86	153	239	210	449	135	113 (8)
2 ...	11	46	57	26	83	143	226	103	329	123	101 (8)
3 ...	26	44	70	36	106	140	246	168	414	110	136 (10)
4 ...	26	15	41	39	80	159	239	190	429	142	121 (11)
TOTALS ...	80	139	219	136	355	595	950	671	1621	510	471 (37)
AVERAGES	1.65	2.9	4.6	2.8	7.4	12.4	19.8	14.0	33.9	11.3	9.8
Test Fed ...	34	41	75	40	115	127	242	176	418	129	187
Pen No.											
6 ...	62	80	142	77	219	167	386	170	556	145	126
7 ...	44	56	100	31	131	124	255	190	445	140	102
8 ...	41	55	99	48	147	123	270	143	413	131	98
TOTALS ...	181	232	416	196	612	541	1153	679	1832	545	513
AVERAGES	3.8	4.9	8.7	4.1	12.8	12.3	24.1	15.4	38.2	12.2	12.8

thyroid has a marked effect on growth, moulting, feathering, and egg production in poultry. This is observed particularly in the aged bird when a decrease in thyroid secretion results in a slowing down of all the body processes with development of symptoms of senescence. In such cases feeding of the appropriate quantities of dried thyroid gland results in a rejuvenating effect on the birds with moulting, followed by the production of plumage similar to that of a young bird, together with a marked increase in egg production. These considerations have supplied the impetus to many investigations on the effect of thyroid gland in poultry husbandry. Among these may be mentioned the work of Crew (1925), who stated that following the administration of thyroid gland to old birds (6-8) years "the birds moulted without exception and hens quickly started to produce eggs at a much higher rate. With the passing of the moult, the head furnishings became red and turgid, the plumage tight and close. All the birds became

rejuvenated, looking fresh and being active." This work confirmed by Zawadowsky *et al* (1928), received a fresh stimulus when Reinecke and Turner at the University of Missouri Agricultural Experiment Station produced an iodised protein having the properties of natural thyroid protein by the action of iodine on casein in alkaline solution. This substance has recently been the subject of an extensive investigation carried out under the auspices of the Agricultural Research Council mainly on the effect on lactation in cows (Blaxter, 1943, and symposium in Journal of Endocrinology, 1945), and Reinecke and Turner (1945) reported experiments which showed that the addition of a small quantity of iodised casein ("Protamone") of the order of $\frac{1}{3}$ oz. per 100 lb. of feed had a marked effect on increasing the egg production of 2-year-old White Leghorns. In a private communication from Dr. C. W. Turner we have recently heard that this work is being extended to more aged birds with satisfactory results.

RIOD EST FEEDING

No.	June		July		August		Sept.		Oct.		
135	113 (8)	697	91	788	93	881	41 (6)	922	10 (2)	932	No. of birds still laying shown in ( )
123	101 (8)	553	130	683	106	789	25 (8)	814	1 (0)	815	
110	136 (10)	660	87	747	89	836	30	866	3	869	
142	121 (11)	692	121	813	92	905	14 (3)	919	6 (0)	925	
510	471 (37)	2602	429	3031	380	3411	110 (30)	3521	20	3541	
11.3	9.8	54.2	8.9	63.2	7.8	71.0	2.3	73.4	0.4	73.8	
129	187	734	159	893	105	998	36 (8)	1034	36 (5)	1070	4 birds each stolen from Pen Nos. 7 & 8 in June
145	126	827	110	937	106	1043	65 (7)	1108	40 (5)	1148	
140	102	687	87	774	50	824	42 (8)	866	32 (5)	898	
131	98	642	85	727	59	786	38 (6)	824	31 (5)	855	
545	513	2890	441	3331	320	3651	181	3832	139	3971	
2.2	12.8	72.4	11.0	83.4	8.0	91.2	4.5	95.8	3.5	99.3	

The work here reported was planned in the summer of 1944 and extended over the autumn and winter of 1944-5 and 1945-6, prior to the publication of Reinecke and Turner's results. It was designed to test the effect of supplementation of the ration with iodocasein particularly with regard to the effect on egg production. We submit the results obtained in complete confirmation of those of the American workers.

1944-45 Trials

The tests were carried out on birds of varying ages, some past the age when production was considered economical. All the birds were housed in 8 ft. by 6 ft. Colony type breeding houses, fitted with perches and dropping boards. Deep litter was provided on the floor for scratching.

The iodised casein was prepared by the iodination of casein in alkaline

solution as described by Reinecke and Turner (1942) and had a total iodine content of 5.54 per cent. and thyroxine iodine of 1.28 per cent. The birds were fed normal rations supplemented by (a) 12 per cent. of a *control meal* consisting of groundnut meal (protein 52 per cent., oil 0.75 per cent., fibre 6 per cent.), or (b) 12 per cent. of a *test meal,* consisting of groundnut meal containing 2 per cent. of iodised casein. The morning feed was 1 oz. of grain per bird given in the litter. Wet mash containing the special mixture was fed in troughs as evening feed, the quantity being regulated to the amount the birds could eat in 30 minutes. The birds had access to a grass run during the day.

The egg production figures were not too promising at first sight but there were several points to be taken into consideration. Firstly, the majority of the birds were in lay when moved into the pens for the trials, and due to the heavy rains of November these birds went into a moult and consequently out of production. The trial had been confined mainly to aged birds to examine the possibility of rejuvenation, though experience has shown that in very few cases is the effect of forcing mixtures successful. It was noted though that, although the test-fed birds had a bad start, by the end of the trial they had caught up with and in the last month surpassed the controls. During the whole of the trial the healthy condition of the birds was most impressive being particularly noticeable in the droppings. This, together with the casual observation that the increase in production in the test-fed pens was most marked after the period of recording, led us to continue the trials over a further and more prolonged and better controlled series.

1945-46 Trials

The iodised casein used in this trial was prepared by the same method, and on analysis was found to contain 7.66 per cent. of total iodine, 2.0 per cent. of thyroxine iodine, and 0.25 per cent. of inorganic iodine. Groundnut meal was again used as a basis for the fortified meal and was blended so that when ½ oz. of the fortified meal was added to 7 oz. feed it gave the equivalent of 10 grams of iodised casein per 100 lb. of feed.

Four pens each consisting of 12 Rhode Island Red yearlings were used for the controls and test-fed sections. The birds received the special mixture for six months from November to April, after which they were put on a normal ration, egg records being kept until the end of October.

The accompanying table summarises the laying records throughout the trial. The first column shown for each month represents the egg record for the month, while the second column gives the totals to date. The figures in brackets indicate the number of birds still laying in each pen. It should be noted that in June four birds were stolen from pens 7 and 8, the reduced numbers being allowed for in the calculations of the averages.

The following observations may be made from the data collected:

(1) The total number of eggs in the test meal pens was increased by 12.2 per cent. over the whole period despite the fact that the number of birds in these pens was reduced by 16.6 per cent. during the last five months of the first trial when the effect of the supplement was most marked.

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(2) Over the whole period the average number of eggs per bird was increased by 25.4 per cent.

(3) The effect of the supplement appears to be rather an extension of the production time than an increase in production during the peak period. This is explained by the rapid fall off in the number of birds in lay in the control pens as compared with the test pens.

(4) Moulting was retarded amongst the test-fed birds as compared with the controls and, in general, the former were very much fitter.

Conclusions

We may conclude that the addition of a small amount of iodised casein, 10 g. per 100 lb. of feed, increases egg production by 20-30 per cent. by prolongation of the period of production.

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THE STUDIES ON THE BLOOD OF DOGS—II
Hæmatological findings in (A) apparently healthy dogs harbouring intestinal parasites; (B) dogs infested with Spirocerca sanguinolenta

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(A) Hæmatological Findings in apparently healthy Dogs harbouring Intestinal Parasites

Among dogs ordinarily brought to the laboratory for experiments, a large proportion may be discovered to harbour intestinal parasites although they seem on superficial inspection to be of about the same condition as regards health as those usually accepted as normal dogs. In our first paper, it was stated that only those discovered to be free from intestinal parasites were designated normal dogs. Besides the 74 dogs thus taken to be normal, there were received 154 dogs that were discovered to be infested with intestinal parasites and were in apparently good health, namely, 29 adolescent dogs and 125 adults, 49 being bitches and 105 male dogs. These were divided into three lots, namely: (1) those suffering from "Cestode" infestation; (2) those suffering from "Nematode" infestation; and (3) those suffering from both "Cestode" and "Nematode" infestation.

In all cases careful examination of the fæces was made during life and, *post mortem,* a close search was made for the presence of worm parasites in the

Results

TABLE I

LOT 1.—CESTODE INFESTATION

Blood Picture	Mild Infestation			Heavy Infestation		
	Min.	Max.	Aver.	Min.	Max.	Aver.
R.B.Cs. ...	3,350,000	7,290,000	5,207,000	4,500,000	7,730,000	5,605,000
W.B.Cs. ...	8,000	17,600	10,770	7,400	19,800	11,454
Hb. % ...	38	64	53.5	49	62	55
Hb. g. ...	6.6	11	9	8.5	10.6	9.4
C.I. ...	0.44	0.65	0.51	0.37	0.64	0.49
Ret. % ...	0.0	2.8	0.6	0.0	2.2	0.9
Bas. % ...	0.0	0.6	0.09	0.0	2.0	0.2
Eos. % ...	4.6	17.0	9.2	1.4	20.0	7.3
Myel. % ...	0.0	0.0	0.0	0.0	0.0	0.0
Juv. % ...	0.0	3.4	0.5	0.0	3.0	0.5
Stab. % ...	4.0	12.4	7.5	1.6	9.4	4.2
Seg. % ...	45.0	71.0	55.5	49.7	75.2	58.0
Neut. % ...	52.5	82.4	63.5	53.0	76.8	62.5
Lym. % ...	1.6	28.0	16.5	8.5	38.3	21.7
Mon. % ...	8.0	15.4	10.7	2.3	16.4	8.1

alimentary tract and other parts of the body. These examinations revealed a heavy infestation in most of the dogs discovered to harbour the parasites.

Depending on the degree of infestation, each lot was again subdivided into those that were (*a*) heavily infested and (*b*) mildly infested.

From the data in the table one may conclude that the red cell count is lower in the mildly infested than in the heavily infested cases, and the same applies to the hæmoglobin concentration. This paradoxical finding would probably have reference to the chronicity of infestation in the discoverably mild cases. There was no significant difference as between mild and heavily infested cases in the total leucocyte counts, or the neutrophile percentage. On the whole there was a marked relative and absolute eosinophilia in the blood of dogs suffering from mild infestations and a moderate eosinophilia in those suffering from heavy infestations. In a few cases, infestation failed to produce a marked or even a moderate eosinophilia. The lymphocytes tended to be low in mild cases, while in heavily infested cases there was a very great increase. The monocytes were the least affected, the average percentage being much higher in mildly than in heavily infested cases. A slight shift in the Schilling index was noticed: immature cells increased to 6 per cent.

Comparing these data with those of normal dogs, it is noticeable that the red cell count, the hæmoglobin percentage and the total leucocyte count were slightly lower in infested dogs. A slight chronic anæmia was manifested by dogs suffering from tapeworm infestation.

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TABLE II

LOT 2.—NEMATODE INFESTATION

Blood Picture	Mild Infestation			Heavy Infestation		
	Min.	Max.	Aver.	Min.	Max.	Aver.
R.B.Cs. ...	3,540,000	6,700,000	5,320,000	3,420,000	7,420,000	5,440,000
W.B.Cs. ...	4,400	19,800	11,596	4,600	18,800	12,088
Hb. % ...	41	68	57	40	73	56
Hb. g. ...	7.2	11.6	9.8	7.0	12.4	9.6
C.I. ...	0.42	0.77	0.55	0.43	0.63	0.52
Ret. % ...	0.0	3.6	0.54	0.0	3.3	1.01
Bas. % ...	0.0	0.5	0.03	0.0	2.7	0.12
Eos. % ...	5.0	29.6	10.7	2.6	36.5	9.13
Myel. % ...	0.0	1.3	0.08	0.0	1.7	0.07
Juv. % ...	0.0	2.0	0.5	0.0	4.0	0.6
Stab. % ...	3.0	37.0	11.7	1.6	26.0	7.7
Seg. % ...	23.7	73.0	53.3	29.3	76.6	57.4
Neut. % ...	40.0	80.0	65.5	37.3	84.7	65.8
Lym. % ...	5.0	37.0	17.4	5.0	49.7	15.6
Mon. % ...	1.3	14.4	6.3	1.3	30.0	9.3

The red cell count for mild cases was below the count of the heavily infested cases. The number of white blood cells per c.mm. for this lot as a whole varied a great deal.

TABLE III

LOT 3.—CESTODE AND NEMATODE INFESTATION

Blood Picture	Mild Infestation			Heavy Infestation		
	Min.	Max.	Aver.	Min.	Max.	Aver.
R.B.Cs. ...	4,000,000	7,200,000	5,690,000	3,100,000	7,350,000	5,170,000
W.B.Cs. ...	7,300	19,800	11,227	2,800	19,000	11,197
Hb. % ...	40	76	58	40	70	55
Hb. g. ...	7	13	9.6	7	12	9.4
C.I. ...	0.40	0.62	0.51	0.38	0.73	0.54
Ret. % ...	0.0	6.0	0.9	0.0	6.6	0.97
Bas. % ...	0.0	0.3	0.03	0.0	0.4	0.02
Eos. % ...	4.5	17.0	10.2	3.3	28.0	7.4
Myel. % ...	0.0	0.0	0.0	0.0	0.0	0.0
Juv. % ...	0.0	2.5	0.2	0.0	5.0	0.5
Stab. % ...	3.0	15.0	8.0	1.0	20.0	7.9
Seg. % ...	42.0	63.3	53.4	42.0	78.3	55.0
Neut. % ...	55.0	74.3	62.4	33.0	79.0	63.4
Lym. % ...	6.0	30.0	19.0	8.0	39.0	18.8
Mon. % ...	3.5	21.0	8.3	1.3	25.6	10.8

In this lot, unlike the previous two lots, the red blood count and the hæmoglobin percentage were higher in mild cases than in heavily infested cases, while

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the total leucocyte count showed no significant difference between the mild and heavily infested. The data concerning the neutrophiles agreed well with those recorded for the cestode lot. Mild cases showed marked eosinophilia, while the heavily infested cases showed only a moderate eosinophilia. There was a slight lymphocytosis in this lot.

Discussion

Intestinal parasites are believed to influence both the red cell count and the hæmoglobin content. The red cell count showed a slight decrease below the normal in all the above three lots. The red cells were usually of normal size and shape and they presented invariably a central pallor—so much so that sometimes, as when the change was most advanced as in mild cases of worm infestation, the cells appeared as mere rings. It was thus found that in infestation with intestinal parasites the picture was always that of a secondary anæmia. The low red cell count, together with the proportionately low hæmoglobin content characteristic of a secondary anæmia, resulted in a colour index of 0.52 or even below, which is only very slightly below that recorded in our first paper for non-infested dogs.

Burnett (1908) states that there are many parasites that produce an anæmia, with a red cell count falling as low as 1,750,000 per c.mm. Merrit, P. S. (1929) found an anæmia following an infestation of young dogs with *Ancylostoma caninum* larvæ, but no anæmia resulted from the infestation of adult dogs. He states that this is an indication of the small number of worms which can develop in older dogs. Nicoll (1914) similarly found that it was impossible to produce a severe anæmia in adult dogs, although a fatal and acute anæmia followed infestation in young dogs.

Intestinal parasites caused a slight decrease in the total number of leucocytes in the blood, although this was not a constant feature. As shown in the tabulated summaries, the neutrophiles and monocytes were the least affected, while the basophiles and lymphocytes were moderately increased above their normal values.

There was a marked relative as well as an absolute increase in the number of eosinophiles in the blood of dogs with a mild parasitic infestation, and a moderate increase in those showing heavy infestation. This eosinophilia attained its maximum average in dogs infested with the nematodes, and in these cases the lymphocytes were greatly decreased. Conversely, eosinophilia attained its minimum average and lymphocytes their maximum average in dogs infested with cestodes. The percentage of eosinophiles in the peripheral blood of the affected dogs varied greatly, from 1.4 to 36.5 per cent., with an average of 9 per cent. In a few cases, as shown by the data in the tables, infestation failed to produce a marked or even a moderate eosinophilia.

It would thus appear that the degree of eosinophilia gives no indication as to the intensity of the parasitism in dogs, though it may provide some indication of its chronicity. Until recently the presence of an unusually large number of eosinophiles in the blood was considered to be almost diagnostic of a severe infestation with external or internal parasites, while on the other hand an absence

of eosinophilia was held to present very strong evidence that the animal was almost, if not entirely, free from parasitic invasion.

During the past few years, however, our knowledge regarding the relationship between parasitic infestation and an eosinophilia has been undergoing a considerable change. Eosinophiles are quite consistently increased in infestation with various intestinal parasites; thus infestation with various tapeworms, round worms or both, cause a varying degree of eosinophilia. Apparently this is not caused by the mechanical features of the infestation, since it has been shown that the *ingestion* of an extract from the round worm *Ascaris* will cause, in some manner unknown, the stimulation of the production of eosinophiles by acting on the bone marrow. Moreover, some individuals, and more especially adults, may show a relative resistance to worm invasion which modifies greatly the response of the bone marrow. This may act in such a way that inhibition of the response may be produced by assimilation of the products of a heavy worm burden while stimulation may be produced when the animal body is succeeding to keep it down to a mild one.

Numerous workers have noted a decrease in the number of eosinophiles in the blood following the subcutaneous injection of toxic extracts of parasites, and of substances of non-parasitic origin. Merrit, P. S. (1929), found a decrease (eosinopenia) in the number of eosinophiles in the blood following infection of dogs with the larvæ of *A. caninum*. This was believed by him to be due to the attraction of these cells to the neighbourhood of the parasite (i.e. to be a withdrawal from the general blood circulation caused by a local eosinophilia). The eosinophilia which occurs later in the blood, according to him, would seem to result from compensatory overproduction of eosinophiles by the hæmopœitic tissue in response to the presence of the parasite. Weinberg and Séguin (1914) had found similar changes in the number of eosinophiles in the blood when verminous toxins were injected into animals. They observed that local eosinophilia occurred at the expense of the eosinophiles in the blood, although the decrease in the number of eosinophiles in the blood was only temporary and was followed by an increase above normal. Nicoll (1914) failed to find eosinophilia as a constant occurrence in dogs infested with *A. caninum* but his observations were not made soon enough after infection to detect changes.

The results reported by some observers are in agreement with our results. For example, Pepper and Farley (1934) state that eosinophilia is not constant in tæniasis and far from constant or marked in ascariasis, oxyuriasis, etc., while Cabot (1898) reports that there is a marked relative and absolute increase in the number of eosinophiles during the acute stage of the disease, but in long-standing or quiescent cases the eosinophilia may disappear. He also states that in ordinary cases of tapeworm infestation, many of which he examined, he did not usually find eosinophilia.

Summary and Conclusion

The blood changes in 154 dogs showing no marked clinical symptoms of helminthiasis but found to harbour intestinal parasites in either large or small

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numbers were investigated. The general results were as follows, depending on the kind of infestation :—

(*a*) *Tæniasis.*—Anæmia sometimes occurred in this infestation. Affected animals may exhibit a slight reduction in the red cell count and hæmoglobin content, as well as in the white cell count. There was often a slight eosinophilia accompanied by a moderate degree of lymphocytosis. Eosinophilia was far from being a constant feature in tæniasis but occasionally it was marked.

(*b*) *Ascariasis.*—Few instances of anæmia were recorded. Eosinophilia was the rule—often exceeding 36.5 per cent. of the normal total count. The number of lymphocytes showed no significant change in any of the cases.

(*c*) *Combined Tæniasis and Ascariasis.*— Anæmia and eosinophilia sometimes occurred, the former being a secondary character with reduced hæmoglobin content. Although the anæmia seemed to be dependent in some degree upon the chronicity of the infestation, many infested individuals exhibited little or no anæmia.

General Effects on the Blood Picture in Intestinal Helminthiasis.—The changes in the blood in intestinal parasitic infestation varied a great deal. In many cases there was simply a slightly lowered number of red cells, to an average of 5,405,000 per c.mm., the hæmoglobin percentage remaining practically normal (57 per cent.). Change in the size, shape and staining reactions of the red cells could be seen in some mild cases of infection. Many of the red cells showed lack of hæmoglobin indicated by the increased size of the central clear area.

In many cases of intestinal helminthiasis, a moderate eosinophilia is present to a greater or lesser extent; it is of definite diagnostic significance in infection with nematodes. The relative and absolute number of lymphocytes is irregularly increased above the normal value in infestations with cestodes.

It is perhaps of special interest to note that no significant change was observed in the total leucocyte count or in the percentage of the neutrophiles and monocytes. A slight decrease was recorded in only a few cases.

Among the dogs received for investigation this parasite was found in tumours in the œsophagus and less frequently in the stomach. One seldom meets with more than two tumours in one host; the tumours may reach the size of a hazel nut. The disease was often undiagnosed during life, but on post-mortem examination, tumours lying beneath the mucosa of the œsophagus and limited outwardly by the muscular coat were noticed. Upon incision the tumour was found to contain a cavity which, on pressure, exuded a purulent fluid with which were extruded the parasites. A varying number of worms, up to six, but generally two or three, were found coiled up in these chambers. They were reddish in colour. The male was 3 to 5 cm. long, with two unequal spicules in the spiral tail. The female was about twice this size. The following table summarises the data recorded on the blood picture of 23 dogs showing tumours containing *Spirocerca sanguinolenta* in the œsophagus and stomach. All 23 dogs were also infested with different intestinal parasites. No symptoms were exhibited during life. No abnormalities other than the tumour were detected.

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Blood Picture		Min.	Max.	Aver.
R.B.Cs.	... ...	4,080,000	6,380,000	5,250,000
W.B.Cs.	... ...	3,600	27,400	13,730
Hb.	%	45	75	57
C.I.	... ...	0.42	0.69	0.55
Ret.	%	0.2	5.0	1.3
Bas.	%	0.0	1.0	0.08
Eos.	%	5.0	58.0	17.3
Myel.	%	0.0	5.8	0.6
Juv.	%	0.0	5.0	1.4
Stab.	%	1.8	23.0	11.8
Seg.	%	20.0	64.0	45.2
Neutr.	%	31.0	80.7	59.2
Lymph.	%	3.6	36.0	17.2
Mon.	%	1.4	14.7	6.4

The blood pictures showed the following characteristics :—

There was marked decrease in the red cell count accompanied by an increase in the reticulocytes. There was a very slight increase in the hæmoglobin content with a higher colour index. The total leucocyte count was increased. The differential leucocyte count showed a neutropœnia with absolute and relative eosinophilia, figures as high as 58 per cent. eosinophiles being recorded. There was no significant change in the percentage of lymphocytes. The monocytes were moderately decreased. The Schilling index showed either no deviation or a slight shift to the left.

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REVIEWS

The Dog and Camera. By HENRY C. STACY, A.R.P.S. 1st Edition. London : The Fountain Press. Price : 8s. 6d.

MR. STACY is an exceptionally gifted technician with the camera. He also has the artist's touch. These books will give delight to all lovers of dogs and cats. I believe that they may even convert those who do not hold these animals in such high regard for he seems to have caught his subjects in those appealing attitudes and poses which will appeal to and soften a heart of stone.

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The Veteran. Vol. 1, No. 1. Autumn, 1947. The Magazine of the Glasgow Veterinary College.

COLLEGIATE life is not complete without a magazine wherein may be set forth an account of student and college activities. In particular a well-run and lively magazine can become the pulse of the student body for it records everything from sport and other activities to grousing.

This magazine was planned initially as the journal of the Glasgow College branch of the British Legion and the enterprise of the ex-Service students must have stimulated the others, for now by arrangement it is to become the joint concern of the S.R.C. and the G.V.B.

If the first issue can be taken as a criterion of future numbers, the magazine is certain to prosper. Its contents provide interesting and instructive reading and the editors are to be congratulated on the range and variety of its articles. There are forewords from the Principal and the President of the R.C.V.S. Paper, printing and illustrations are good and the cover in R.A.V.C. maroon is embellished by the College crest.

Old students will welcome the effort and we hope that they will respond nobly not only to the subscription lists but also to the invitation to contribute to its columns.

The Right Way to Keep Dogs. By R. C. G. HANCOCK, B.Sc., M.R.C.V.S. London: The Rolls House Publishing Co., Ltd. Price: 5s.

ANOTHER book intended for those who own or anticipate owning a dog. This book is probably the most complete for its size of the many published in recent years. It will be of especial interest to those who are already dog owners. In its pages one can find something on everything appertaining to dogs, from rearing, feeding, breeding, training, nursing and showing, to notes on diseases, and the law relating to dogs.

This small book contains, however, a few assertions and opinions with which one is tempted to differ, or ask for further enlightenment. For example, there is a passage containing the following statement: "Many a sheepdog puppy, shown a flock for the first time, performs many of the evolutions of shepherding without instruction." Many do not; in fact, most require the example of an older trained dog. Also many puppies, other than sheepdogs, will show an aptitude for the same work. So it would seem that the inference drawn is faulty. Acquired characteristics of behaviour, afforded by training, are not hereditary. A particular breed is especially suited for a certain purpose, because the normal intelligence, temperament and physical attributes of that breed make it more suitable for appropriate training.

Again, it is asserted that dogs "riding" the legs of humans can be quickly cured of the habit if the prostate is attended to!! Many Veterinary Surgeons will not understand this. Neither will many agree that intestinal parasites in reasonable numbers may be beneficial, although most will agree that they may be, and often are, harmless. It is interesting to note that the talented artist responsible for the illustrations is the author's daughter. H.D.M.

Good and Healthy Animals. By J. D. PATERSON. London: English University Press, Ltd. Price: 4s. 6d.

THIS book is intended for stockowners and other laymen who tend animals, and from the Veterinary Surgeon's point of view it is of an elementary nature. There is no doubt that it will serve well the purpose intended, i.e., to provide an easily understood account of animals in health and disease.

Those who read, mark and learn the lessons of this book will be in a position to co-operate with the Veterinary Surgeon in his fight against disease.

H.D.M.

Die Nervenkrankheiten des Rindes (The Nervous Diseases of the Bovine, including Elements of Comparative Neurology of Man and the Domestic Mammal). By E. FRAUCHIGER and W. HOFMANN. Bern: Hans Huber, 1941. Price: Fr. 24.

THIS splendidly produced book should be translated into English. The work is the result of many years of collaboration in observation and research of Dr.med.vet. W. Hofmann, Professor of Bovine Medicine, and Dr.med. E. Frauchiger, Lecturer of Comparative Neurology, both in the University of Bern.

The book, therefore, is much more than an attempt at summarising the present knowledge of the nervous diseases in cattle, as the authors modestly claim. It is a systematic approach to the neurology of a domestic genus, applying where possible the methods commonly used in human neurology, thus leading to a deeper understanding of mammalian disease and reversely illuminating diseases, especially virus infections, in man.

At the moment the conditions of clinical diagnosis and observation in veterinary practice make it impossible to assess the incidence of nervous diseases in domestic mammals. In cattle it certainly is higher than the figure of 4 per cent. shown in an insurance statistic of the Kanton Zuerich for the years 1896 to 1932. The importance of the bovine from the point of view of numbers, economy and contact with man is sufficient justification to concentrate first of all on the nervous disorders in cattle.

The book is divided into two parts. The first part describes briefly the clinical anatomy of the nervous system and in some detail the methods of clinical and laboratory examinations (some 70 pages). The practical application of these methods no doubt requires considerable experience.

Unfortunately, the present knowledge of the histology and physiology of the central nervous system of the large domestic mammals is very incomplete. For instance, the predominance of the extrapyramidal, cortico-striato-tegmental-(rubro)-spinal system in these animals in relation to their somatic reflex responses is of the greatest significance for the evaluation of anomalies. Reference to disorders of the pyramidal system, prevalent in man, may be misleading although of great interest from the comparative point of view. The interaction of the two systems in the large domestic mammals is completely unknown. A field easier of approach may be a detailed study of the postural reflexes and stance and gait in the normal and diseased bovine, with special reference to localised

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anatomical lesions. Such observations may, in fact, help in overcoming some of the great difficulties of clinical examination of somatic reflexes as well as of motor and sensory deficiencies.

Incidentally, the afferent pathways, such as the spinothalamic tracts, and their projections to the cortex are largely unknown. E. D. Adrian's pioneer work on the receptive cortical areas representing the most sensitive skin receptor fields in the sheep and goat (pony and pig) are not mentioned.

For the time being clinical and pathological examination, both serological and anatomical, seem the most promising line of approach, and the second part of the book is a most useful guide in this direction. Considering the fact that mammalian neurology is in its infancy, it is not surprising that in the preliminary survey of their material the authors find a considerable percentage of diseases of some clinical semblance grouped together which most likely comprise cases of very different origin, i.e. of uncertain diagnosis. The authors stress that the distribution of nervous diseases in man and cattle is very different, and that the treatment also has entirely different aims and possibilities. With respect to prophylaxis of hereditary diseases, the chances appear more hopeful in cattle—where eugenic methods can be employed—than in man, where it is hard to restrain individual choice and reproduction.

It seems to the present writer that the veterinary surgeon will derive great benefit from the second part of this book; from the practical point of view the chapters on the diseases of the muscular system and on functional nervous diseases, including the tetanies, are of special interest.

As a whole the book is a fascinating introduction to a vast field of clinical activity and applied research. H.R.

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